Musculoskeletal Symptoms Among Female Garment Factory Workers in Sri Lanka

by

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Thesis submitted in partial fulfillment of
the requirements for the degree of Masters of Science in the Department of Global
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ABSTRACT

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Abstract

Background: The garment industry in Sri Lanka employs an estimated 400,000 individuals, the majority of which are women. Garment factory workers are exposed to physical demands and repetitive nature of industrial work, placing them at risk for work-related musculoskeletal disorders.

Objectives: To assess the types and extent of work-related musculoskeletal health problems experienced by female garment factory workers in Sri Lanka, and to identify risk factors associated with higher rates of musculoskeletal disease in this population.

Methods: A cross-sectional study was conducted in a simple random sample of 1058 female garment factory workers in the Free Trade Zone (FTZ) in Kogalla. Socio-demographic and occupational health data was collected via interviewer-administered survey, while a self-administered questionnaire (WHOQOL-BREF) was used to assess worker quality of life. Crude prevalent odds ratios were calculated for key demographic variables (age, BMI, job type, education, tenure, income). Variables demonstrating important association with the outcome (musculoskeletal complaints of any type) were retained in the final multivariate model.

Results: 164 (15.5%) of workers reported musculoskeletal symptoms occurring more than 3 times or lasting a week or greater during the previous 12-month period. The

back was the most frequently affected region (57.3%), followed by knees (31.7%), shoulders (9.1%), hand and wrist (7.3%), neck (6.7%), and forearm and elbow (3.0%). Average symptom severity was moderate, and most individuals (55.8–83.3%) reported difficulty maintaining work quality as a result of their pain. Nearly all women (>90%) felt their problems affected their leisure activities and household work, though few reported missing work as a direct consequence of their discomfort. Frequency of musculoskeletal complaints increased monotonically with increasing age. Higher monthly income, 60 or more months spent working in the industry, and lower educational attainment all correlated positively with complaints. No significant relationships were identified for BMI or job type. In multiple regression analysis age, time in the industry, and monthly income were significantly associated with musculoskeletal complaints for any location. Those with any complaints were more likely to report moderate or worse quality of life and health satisfaction.

Conclusion: Musculoskeletal complaints among female garment workers in the FTZ of Kogalla are surprisingly low. Though this population is quite young and sociocultural factors may effect a degree of underreporting, the generally good health of Sri Lankan workers suggests that the developing world industries can achieve safe work environments within their FTZs factories. Further research is necessary to better understand mental health problems within this population.

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1. Background

1.1 *Musculoskeletal Disorders*

Musculoskeletal disorders (MSD) encompass a wide range of physical health problems involving muscles, ligaments, tendons, joints, blood vessels, and nerves. Pain may occur in any location in the body, though the lower back, neck, shoulder, and wrist are among the most frequently reported sites (World Health Organization, 2003). While some conditions may be recognized as a clinical syndrome by their reproducible constellation of symptoms (*e.g.* rheumatoid arthritis, carpal tunnel syndrome), a significant proportion of complaints escape diagnosis or are assigned a less well-standardized diagnosis (*e.g.* regional pain syndrome). Furthermore, the exact diagnostic criteria for some conditions, such as osteoarthritis, may require expensive radiologic or laboratory testing unavailable in poorer communities. This difficulty of classification has rendered efforts to estimate local and worldwide burden quite difficult (World Health Organization, 2003).

The pathophysiology of MSD is similarly broad and can be associated with acute (*e.g.* injury), sub-acute, or chronic (*e.g.* degenerative) conditions. In the developed world, repetitive motion injuries are among the most common, while developing countries experience a substantial amount of musculoskeletal disease attributable to acute traumatic injury. Despite the many possible causes, however, pain and inflammation are among the most common symptoms reported by those suffering from

MSD. The degree of physical impairment varies widely, ranging from mild discomfort to complete impairment, with inability of the sufferer to complete basic activities of daily living.

This class of disease (MSD) is among the most common in the world, affecting individuals of all ages, sexes, socioeconomic classes, and ethnicities. Given the difficulty of obtaining accurate estimates of musculoskeletal disease burden, however, research assessing risk factors, mental and physical impact, and resource utilization of affected populations in the developing world is limited (World Health Organization, 2003). Extrapolation from studies conducted in industrialized nations anticipates numerous demographic and environmental risk factors, many being non-specific and frequently associated with a host of other illnesses. Advancing age, history of injury, repetitive or awkward work-related activities, obesity, malnutrition, medical comorbidities, smoking and high alcohol intake are among the most commonly noted factors in the developed world (World Health Organization, 2003). Despite the difficulty of obtaining reliable cross-comparable data, there is emerging evidence that geographic and socioeconomic determinants also play a role. South-East Asian populations, for example, report lower rates of hip disease than Caucasians, while knee disease is more common in Blacks than Caucasians (World Health Organization, 2003).

1.2 Musculoskeletal Disorders in the Workplace

Disorders of the musculoskeletal system are the single largest group of work-related illness in the developed world (Punnett & Wegman, 2004). Some conditions and body regions are associated with certain industries and job features. Lower back pain, for example, has been connected to warehouse work, repetitive lifting of heavy loads, and prolonged exposure to whole body vibrational forces (Chaff & Park, 1973; Waters, Dick, & Krieg, 2011). Societal and individual losses resulting from MSD are significant, taking the form of reduced productivity, absenteeism, and diminished quality of life (McDonald, DiBonaventure, & Ullman, 2011). Public health efforts to address the substantial disease burden have emerged primarily in the form of government-mandated regulation of the work environment as well as ergonomic interventions targeting the individual worker.

1.2.1 Risk Factors for Musculoskeletal Disease in the Workforce

1.2.1.1 Individual Factors

The association between MSD and numerous sociodemographic factors is well documented in the literature. Population-based studies conducted in Canada, Finland, Sweeden, and the United Kingdom identified gender, increasing age, education, and personal smoking history as important predictors of MSD (Mäkelä, Heliövaara, Sievers,

Impivaara, Knekt, & Aromaa, 1991; Badley & Ibanez 1994; Palmer, Syddall, Cooper, & Coggon, 2002; Schulte, Wagner, Ostry, Blanciforti, Cutlip, Krajnak, *et. al.*, 2007).

Females are more likely than their male counterparts to report MSD symptoms in any body region (US Department of Health and Human Services, 1997). In an office work setting women were twice as likely to report neck pain (Bernard, Sauter, Fine, Peterse, & Hales, 1994). Women employed in shipyards and assembly plants also described higher rates of neck and upper extremity pain than their similarly employed male coworkers (Alexopolous, Tanagra, Konstantinou, & Burdorf, 2006). One explanation offered by researchers is the greater recruitment of muscular activity as a percentage of their maximal strength (Nordander, Ohlsson, Balogh, Hansson, Axmon, Persson, *et. al.*, 2008). Force exertion is a well-known risk factor for work-related MSD, and women are at higher risk for working at or near their threshold throughout the workday.

A survey of 85,000 Swedish construction workers revealed increasing MSD prevalence with advancing age up to 60 years, followed by a dip in reported symptoms in the oldest age category (Holmström & Engholm, 2003). Interestingly, the trend in MSD rates and age seemed to vary by pain location. Prevalence increased linearly with age for pain localizing to the neck, back, and upper extremity, while hip complaints increased gradually in younger age groups and rose quickly from 40 years of age onwards. A longitudinal study of actively employed US workers in a variety of

industries found no association between age and MSD (Waters, Dick, & Krieg, 2011), however the use of sequential cross-sectional surveys increases the effect of healthy worker bias (Eisen, Holcroft, Greaves, Wegman, Woskie, & Monson, 1997). Lower than expected rates in older workers may result from the selective pressures of poorer health on employment, an epidemiologic bias termed the health worker survivor effect (McMichael, Spirtas, & Kupper, 1974; Holmström & Engholm, 2003).

Socioeconomic factors, particularly lower income and schooling, have been shown to correlate with higher MSD rates in the general population (Badley & Ibanez 1994). The relationship between work-related MSD and socioeconomic indicators, on the other hand, remains unclear. Basic education (< 10 years schooling) was associated with a 4.8-fold increase in neck pain among employed individuals attending primary care clinics in Germany (Blozik, Laptinskaya, Herrmann-Lingen, Schaefer, Kochen, Himmel, *et. al.*, 2009), however this relationship disappeared after adjusting for other factors. Less schooling also had no effect on MSD rates among blue-collar and white-collar workers, though education was inversely related to care seeking-behavior and absenteeism (Alexopolous, Tanagra, Konstantinou, & Burdorf, 2006). This may be due to the greater opportunity of the highly educated white-collar workers to adjust their working conditions to better accommodate impairments associated with MSD (*e.g.* take on more desk-based responsibilities). Similarly, the higher rates of low back pain found in industrialized nations (Woolf & Pfleger 2003) is thought to be related to the

acceptability of back pain as an excuse for absence, aided by the financial protections afforded by worker's compensation benefits (Palmer, Walsh, Bendall, Cooper, & Coggon, 2000; Jin, Sorock, Courtney, Liang, Yao, Matz, *et. al.*, 2000).

A survey of the general UK population found current smokers 20-50% more likely to report musculoskeletal pain that limited activity as compared to lifetime non-smokers (Palmer, Syddall, Cooper, & Coggon, 2002). The influence of smoking on pain varied by the body region affected; the neck, shoulders, and upper extremities being the most affected. Former smokers also had an increased risk of MSD, but at levels below active smokers. A dose-response effect of smoking was uncovered by researchers evaluation MSD risks among metal industry workers in Finland. When compared to never smokers, a 10-20 pack-year (pack-year = packs per week x years smoked) smoking history increased the odds of neck and shoulder symptoms 3.1 fold, low back complaints by 2.4, and lower limb pain by 3.4 (Leino-Arjas, 1998). Smokers with 10 pack-years or fewer had a small increased risk of upper extremity symptoms, but no significant trends were present for pain in other body regions.

1.2.1.2 Workplace Factors

Work-related musculoskeletal complaints have been extensively studied in numerous industries in the developed world (US Department of Health and Human Services, 1997). Workplace factors increasing the risk of injury and disease vary by body

region, most related to body positioning, physical exertion, and exposure to whole body vibrational forces. The majority of the studies have focused on MSD of the neck, upper extremity, and back, though hip and knee problems are gaining in awareness.

Assembly line processes require the worker to quickly repeat a series of movements with little recovery time between cycles. Such working situations were shown to be associated with a 3.6-fold increase in the odds of neck and upper extremity pain among women working in the fish processing industry (Ohlsson, Attewell, Paison, Karlsson, Balogh, Johnsson, *et. al.*, 1995). Shorter recovery time and prolonged periods spent in non-neutral position correlated with higher rates of low back pain among auto assembly plant workers (Punnett, Fine, Keyserling, Herrin, & Chaffin, 1991). Adequate rest periods throughout the workday are especially important for individuals needing to maintain an awkward or static position to complete assigned tasks.

Heavy physical work, including high force-generating lifting and pushing activities, have been linked to MSD of the neck, upper extremity, and low back. Longitudinal surveillance of a cohort comprised of machine operators, carpenters, and office workers revealed a nearly 4-fold increase in the odds of severe neck pain in machine operators as compared to office workers (Viikari-Juntura, Riihimäki, Tola, Videman, & Mutanen, 1994). A survey of Female Finnish nurses found the degree of low back pain to correlate with workload exposure among young nurses (Videman, Nurminen, Tola, Kuorinka, Vanharanta, & Troup, 1984). This relationship did not hold

among older workers, likely due to the presence of a healthy worker bias, however earlier studies conducted in an electronics manufacturing plant seem to support a dose-response effect of heavy lifting (Chaffin & Park, 1973).

The correlation between whole body vibration and work-related MSD has been most definitely shown for low back pain. Numerous studies of bus drivers, helicopter pilots, and tractor drivers have demonstrated an approximate 3-fold increased risk of back pain in these professions (Bovenzi & Betta, 1994; US Department of Health and Human Services, 1997). Despite the strong and consistent link demonstrate between back pain and whole body vibration, there is little evidence that any other body regions are similarly affected. More recently, however, researchers have begun to recognize a relationship between exposure to hand-transmitted vibrations (*e.g.* power tools) and neck and upper extremity symptoms (Palmer, Griffin, Syddall, Pannett, Cooper, & Coggon, 2001). Interestingly the excess risk appears to be higher for distal sites (fingers, wrist) than for proximal ones (neck).

1.2.1.3 Physical Health

The relationship between weight and musculoskeletal pain is well documented with respect to the back, hip and knee joints (Jensen, Mikkelsen, Loft, & Eenber, 2000; Lievense, Bierma-Zeinstra, Verhagen, Verhaar, & Koes, 2001). There is also growing evidence that upper extremity joints may be similarly affected by excess weight

(Wearing, Hennig, Byrne, Steele, & Hills, 2006). Being overweight significantly increased the risk of musculoskeletal pain in the neck and shoulder among adults in Finland, even after adjust for age and sex (Mäkelä, Heliövaara, Sievers, Impivaara, Knekt, & Aromaa, 1991). These results, however, stand in contrast to a survey of Greek shipyard workers that found no association between body mass index (BMI) and rates of reported neck, shoulder, or back pain (Alexopolous, Tanagra, Konstantinou, & Burdorf, 2006). Confounding the relationship between weight and MSDs, obesity increases other health risks for an individual (*e.g.* diabetes, cardiovascular disease) that may further contribute to the development of musculoskeletal disorders.

Physical activity occurring two or more times per week has been associated with significantly lower rates of neck pain and MSD-related absenteeism (Blozik, Laptinskaya, Herrmann-Lingen, Schaefer, Kochen, Himmel, *et. al.*, 2009). No correlation between physical activity and lower back pain was seen in a large Dutch cohort (van Amelsvoort, Spigt, Swaen, & Kant, 2006), however a history of injury to the back was associated with work-related pain in a retrospective study of automotive assembly workers (Punnett, Fine, Keyserling, Herrin, & Chaffin, 1991). This is in contrast to findings from a primary care clinic that found no relationship between cervical injury and ongoing neck pain (Blozik, Laptinskaya, Herrmann-Lingen, Schaefer, Kochen, Himmel, *et. al.*, 2009). Nevertheless, a history of prior injury seems a logical predictor of work-related MSD given the well-documented relationship between chronicity and pain

severity (Alexopoulos, Tanagra, Konstantinou, & Burdorf, 2006; Sullivan, Sullivan, & Adams, 2010).

1.2.1.4 Mental Health

Growing evidence suggests that mental and emotional health is closely tied to MSD prevalence. A cross-sectional study of general clinic patients identified depression and anxiety as significant predictors of neck pain in both crude and adjusted analysis (Blozik, Laptinskaya, Herrmann-Lingen, Schaefer, Kochen, Himmel, *et. al.*, 2009).

Individuals describing higher levels of job stress, inadequate time to complete their work, poor safety climate in the workplace, lack of work freedom, and low job satisfaction in a national survey also reported higher rates of upper extremity and low back pain (Waters, Dick, & Krieg, 2011). While some of these evaluations may have a direct impact on physical work activities (*e.g.* lack of work freedom resulting in prolonged static, awkward positioning), musculoskeletal manifestations of work-related stress are likely due to a psychophysiological response resulting in a prolonged increase in muscle tension throughout the neck and shoulders (Lundberg, Dohns, Melin, Sandsjö, Palmerud, Kadefors, *et. al.*, 1999).

Workers suffering from musculoskeletal pain at any body region scored lower on quality of life testing than those without pain, a relationship that remained significant even after adjusting for sociodemographic factors (McDonald, DiBonaventure, &

Ullman, 2011). Poor to moderately perceived personal health was also associated with higher rates of MSD complaints in working individuals, but did not result in higher rates of care seeking or absenteeism (Alexopolous, Tanagra, Konstantinou, & Burdorf, 2006). Given the cross-sectional design of this study, a linear cause-effect relationship between MSD and health perception cannot be easily deduced. A depressed individual with unfavorable outlook on their health, for example, may be at higher risk for MSD. Alternatively a worker may become depressed and consider his health as a result of symptoms associated with a chronic MSD. For this same reason it can difficult to determine whether poor mental health is the cause or effect of work-related MSDs.

1.2.2 Disease Burden

Indirect estimates of the global burden of occupational disease conducted at the turn of the century arrived at a figure of 38 million disability-adjusted life years (DALYs), approximately 2.7% of the total annual DALYs (Leigh, Macaskill, Kuosma, & Mandryk, 1999). MSDs account for some 3.3 million cases of new work-related illness each year, second only to workplace injuries and accident. An estimated 37% of low back pain (818,000 DALYs) worldwide is attributable to occupational exposures, and was typically higher in regions with lower overall health status (Punnett, Prüss-Üstün, Nelson, Fingerhut, Leigh, Tak, *et. al.*, 2005).

1.2.2.1 Productivity Losses

Losses in worker productivity resulting from work-related MSD pain present a significant societal burden. Absenteeism and presenteeism (job attendance in a reduced work capacity) are costly to both the employer and the worker, the former due to reduced work efficiency and the latter because of decreased earnings. In 2001 the UK economy lost an estimated £5.7 billion due to the combined 9.8 million work days lost as a result of neck, upper extremity, and low back pain (Buckle, 2005). Among a closed population of shipyard workers MSD pain accounted for 22.3% of total sick leaves and 24% of total workdays lost during a 12 month period (Alexopolous, Tanagra, Konstantinou, & Burdorf, 2006). Low back pain, as compared to pain at other sites, was associated with higher rates of absenteeism.

Though difficult to quantitate, the cumulative effect of presenteeism should not be overlooked. A report from the 2005 Canada Community Health Survey revealed that 21% of arthritis sufferers described reduced activity at work (presenteeism) as compared to 3% of individuals with no chronic conditions (Zhang, Koehoorn, & Anis, 2010). The presence of back or arthritis pain nearly doubled rates of absenteeism and the percentage of individuals reporting on-the-job impairment in a population-based US national survey (McDonald, DiBonaventure, & Ullman, 2011). This negative impact of MSD pain on productivity remained significant even after adjusting for demographic and health characteristics.

1.2.2.2 Impact on Leisure and Quality of Life

In addition to the work-related financial losses, individuals with MSDs are likely to describe a reduction in the quantity and quality of leisure activities. US workers with back or arthritis pain were nearly twice as likely to report impairment in daily activities as a direct result of their pain (McDonald, DiBonaventure, & Ullman, 2011). Functional limitations and the resulting restriction of leisure pursuits may reduce self-perceived quality of life: within a cohort of workers actively on 2-6 weeks of sick leave for a work-related MSD, pain severity and quality of life were moderate correlated (van Duijn, Lötters, & Burdorf, 2004). Illness duration appears to influence pain severity and self-perceived quality of life, with chronic conditions associated with higher pain and lower reported quality of life. A small survey of general clinic patients with low back pain found a 10% increase in pain to be associated with a 2.65% reduction in quality of life on day 1 of the illness, while the same pain increment resulted in a 3.8% drop in quality of life on day 10 (Kovacs, Abaira, Zamora, Teresa Gil del Real, Llobera, Fernández, *et. al.*, 2004).

2. Introduction

2.1 Overview

Since the economic liberalization of Sri Lanka in the late 1970s, the country's manufacturing industries have expanded rapidly. Today, garments and textiles are a major source of income and foreign investments, accounting for more than 40% of all exports (Central Bank of Sri Lanka, 2006). This industry employs several hundred thousand women (Central Bank of Sri Lanka, 2006; Hancock, Middleton, & Moore, 2009), many of whom face social problems and hazardous working environments. The government has verbally committed to international labor rights standards (World Trade Organization, 2004); researchers and worker's rights advocates have expressed concerns about the ability of the Sri Lankan government to enforce such regulations in its numerous Free Trade Zones (FTZ). This project aims to evaluate the overall health and wellbeing of female garment workers in Sri Lanka, with a particular focus on the types and extent of work-related musculoskeletal health problems. This information will be valuable to health care providers and policy makers working to improve the health and quality of life of garment factory workers.

2.2 Free Trade Zones in Sri Lanka

Free Trade Zones are designated areas that specialize in intensive manufacturing for the purpose of export. The FTZ program is an important component of Sri Lanka's economic policy and has helped drive the growth of the garment industry over the past thirty years. The government's Board of Investment (BOI) oversees these areas, coordinating infrastructure and negotiating incentives with foreign companies for the establishment of factories in FTZs (Hancock, Middleton, & Moore, 2009). The aim of these collaborative efforts is to encourage capital investment and technology transfer to the country.

There are nine FTZs in Sri Lanka, one of which is Koggala, located in the Southern part of the country near the city of Galle. The FTZ in Koggala encompasses 14 factories, with 10 engaged in the manufacture of garments. These factories employ 10,211 people, seventy-five percent (7,622) of whom are women (Central Bank of Sri Lanka, 2006). As is often the case in FTZ factories, most of these women are young, single, relatively poorly educated and from rural areas (Samarasinghe, 1998; Hancock, Middleton, & Moore, 2009)

2.2.1 Lifestyle and Working Conditions in FTZ Garment Factories

Women working in the garment factories are employed as seamstresses (operating sewing machines), ironers (operating ironing machines), cutters, packers (packaging the garments for shipment), helpers, quality assessment assistants (assessing the products for defects), and supervisors. Employees are paid hourly at rates dependent upon position, experience, and educational attainment (Bharathi, 2007). A 2009 survey by Hancock and colleagues determined the average wage of the female garment worker to be 8,277.48 Sri Lankan rupees (LKR) per month before overtime, and 11,000 LKR per month after overtime (1 USD = 110 LKR).

The promise of work draws women from rural villages throughout Sri Lanka. Those with relations within 40 kilometers of the FTZ can live in their family home and walk or take buses to work. Others traveling from farther away will stay in hostels or boarding houses in or near the FTZ (Bharathi, 2007). The government runs several such boarding houses that are considered to be in better condition than private hostels. There is a waiting list to get into the government hostels with priority given to women who come from the farthest distances. Accommodations, travel fees, and other living expenses can be quite costly, and are primarily covered out-of-pocket by the workers.

2.2.2 Sociocultural Impact of Free Trade Zone Employment

These highly localized sites of industrial production have had an impact on the cultural and social norms within Sri Lanka, thrusting its female workers into a position that straddles the traditional community-centric values and the urbanized West (Attanapola, 2004). Customary practices hold that young girls remain in their families' homes until the time of marriage. The first FTZs in Sri Lanka, however, were situated near Colombo, the country's capital and most populous city. Relocating from a rural village to seek work in an urban setting was counter to the prevailing social norms, at times precipitating disapproval from conservative individuals within the receiving communities (Lynch, 2007)

In more recent years new FTZs, among them Koggala, have been deliberately placed in more rural locations in an effort to both encourage development in non-urbanized communities as well as ameliorate the sociocultural disruptive sociocultural impact of female worker migration (GOPA Consultants, 1991). The effectiveness of this strategy has yet to be tested by a rigorous scientific study, and is beyond the scope this current investigation.

2.3 *The Health and Wellbeing of Garment Workers in Sri Lanka*

Studies conducted both in Sri Lanka and abroad have found numerous health problems among industrial workers in general and garment workers in particular.

Musculoskeletal conditions, gastrointestinal illness, diseases of the respiratory system and eye, dermatological conditions, headache, and on-site injury comprise the main physical health problems faced by garment workers (Chand, 2006; Joseph & Kiran, 2008). Among these health problems, musculoskeletal disorders are the most common and well researched in this population. Work-related stress, depression, and the risk of physical and sexual abuse are significant psychological risk factors for this group, however no epidemiologic estimates currently exist for this population.

2.3.1 Musculoskeletal Symptoms Among Factory Workers

Sri Lankan garment factory workers are exposed to the physical demands and repetitive nature of industrial work, placing them at risk for work-related MSD. An estimated 34% of low back pain among females in the South-East Asian Region (SEAR) D, to which Sri Lanka belongs, has been attributed to ergonomic issues in the workplace (Punnett, Prüss-Üstün, Nelson, Fingerhut, Leigh, Tak, *et. al.*, 2005). Work-related exposures to mechanical risks are further compounded by the long hours, infrequent rest breaks, and poor ergonomics common to performing many workshops tasks (Attanapola, 2004; Sarder, Imrhan, & Mandahawi, 2006; Bharathi, 2007). Such work organization factors have been found to correlate with neck, back, and shoulder symptoms, particularly among female workers (Johansson & Rubenowitz, 1994; Bildt, Alfredsson, Michélsen, Punnett, Vingård, Torgen, *et. al.*, 2000; Tissot, Messing, & Stock,

2009; Wang, Rempel, Hurwitz, Harrison, Janowitz, & Ritz, 2009; Wang, Harrison, Yu, Rempel, & Ritz, 2010).

The effects of long work hours and monotonous, stressful work can be deleterious to both mental and physical health (Attanapola, 2004). Quality assessment workers, for example, may stand for the entirety of their shifts (Hancock, 2005), potentially contributing to the development of lower limb, back, and shoulder pain (Tissot, Messing, & Stock, 2009). Sewing machine operators, on the other hand, are seated and bent forward while performing their work, increasing the likelihood of back, neck, and shoulder symptoms (Westgaard & Jansen, 1992; Sarder, Imrhan, & Mandahawi, 2006; Tissot, Messing, & Stock, 2009).

Prior evaluations of garment workers in India, Bangladesh, Fiji, and Lithuania reveal musculoskeletal complaints to be among the more common health ailments of these predominantly female populations (Gamperiene & Stigum, 1999; Sarder, Imrhan, & Mandahawi, 2006; Chand, 2006; Joseph & Kiran, 2008). Estimates of musculoskeletal disease prevalence vary widely (12-80%), though the distribution of sites of pain remains relatively consistent. Disease of the back, neck, and upper extremity among sewing machine operators are well documented in the literature, being reported by up to half of all respondents (Punnett, Robins, Wegman, & Keyserling, 1985; Blader, Barck-Horst, Danielsson, Ferhm, Kalmpamaa, Leijon, *et. al.*, 1991; Westgaard & Jansen, 1992; Andersen & Gaardboe, 1993). Individuals maintaining strained positions (*e.g.* sewing)

for prolonged periods throughout their shift are more likely to report back and neck discomfort (Roquelaure, Mariel, Fanello, Boissière, Chiron, Dano, *et. al.*, 2002; Tissot, Messing, & Stock, 2009; Deros, Daruis, Ismail, Rifqi, & Rahim, 2010) though packers may be similarly afflicted with elevated rates of neck and upper extremity pain (Gamperiene & Stigum, 1999). Other frequently noted sites of musculoskeletal pain include the knees and thighs, though whether certain tasks within the factory predispose individuals to such symptoms remains unclear (Sokas, Spiegelman, & Wegman, 1989).

Musculoskeletal disorders are more common in female factory workers than in their male counterparts (Schierhout, Meyers, & Bridger, 1995; Häkkänen, Viikari-Juntura, & Martikainen, 2001) and are frequently found at higher rates among older workers (Choobineh, Tabatabaei, Mokhtarzadeh, & Salehi, 2007; Choobineh, Tabatabaei, & Behzadi, 2009). A 4-year, in-plant surveillance program of shoe factory workers in France further revealed psychological distress to be associated with musculoskeletal disease, especially among individuals whose task did not change over time (Descatha, Roquelaure, Evanoff, Mariel, & Leclerc, 2007).

Despite the substantial economic and social influence of the garment industry in Sri Lanka, little is known regarding the health of its many female workers. This cross-sectional survey of female garment factory seeks to explore the prevalence, severity, and factors associated with the report of musculoskeletal pain among female workers currently employed in a garment factory in Koggala, Sri Lanka. This information should

be valuable to health care providers and policy makers working to improve the health and quality of life of factory workers.

3. Methodology

3.1 Study Design

This study was conducted in two phases, relying upon information gathered from focus groups in the first stage to direct the development of the primary survey instrument. Quantitative data was collected during the second phase via the use of three questionnaires: the primary survey instrument and two validated tools useful for assessing general mental health and quality of life. Data management and statistical analysis were done using Stata/IC 11.1 (StataCorp, 2009).

3.1.1 Focus Groups and Survey Development

During the initial qualitative phase four focus groups were conducted with 24 female textile workers employed in factories in the Koggala Free Trade Zone. The women were interviewed in groups of six. Two men who had worked in a textile factory for at least six consecutive months also took part. The focus groups identified musculoskeletal pain, accidental injuries, respiratory problems, dermatological problems, headaches and mental health as significant health problems among garment factory workers.

3.1.2 Data Collection and the Survey Instruments

In the quantitative phase of the study, data were collected by means of a cross sectional survey using the two evaluative tools outlined below. A total of 1058 female workers were selected randomly from a total of 7622 female garment workers employed in the FTZ Koggala, with the number of study participants selected from each factory proportionate to the total number of female workers in the factory. Informed consent was obtained from both factory management and individual workers prior to initiation of each interview.

3.1.2.1 Study Area

The FTZ in Koggala encompasses 14 factories, of which 10 are engaged in the production of garments. Management at nine of the target factories agreed to permit researchers into their facilities during working hours to conduct structured interviews with consenting female employees.

3.1.2.2 Sample Size

The sample size for the textile workers to be included in this study was calculated based on the following formula:

$$\text{Size of the sample } N = \frac{Z^2 P (1-P)}{d^2}$$

$$Z = 1.96$$

P = anticipated population proportion

d = absolute precision required for the estimate to fall within the given
percentage point of the proportion = 3%

The prevalence of occupational health problems among textile workers has not been studied methodically in Sri Lanka. Therefore, 50% was taken as the expected proportion of occupational health problems in female textile workers (P = 50%). Substituting the above values in the above equation the required sample size = 1067.

3.1.2.3 Sampling Technique

A simple random sampling method was used to select female workers for participation. A number between 1 and 7 was selected at random for each factory site; this indicated the first individual selected from the worker register. Every seventh subsequent name was also identified. The resulting list was presented to factory management at the beginning of the 2-week long survey period, during which the survey takers attempted to interview all women at a given site. Floor supervisors made the final decision of when to send workers for interview, often during the lunch hour or tea break. A total of 1067 were selected from 7622 female garment workers employed in the FTZ Koggala, with the number of study participants selected from each factory

proportionate to the total number of female workers in the factory. Of this initial group, 1058 were successfully contacted and offered participation in the study.

3.1.2.4 Primary Survey Instrument

The primary survey instrument was designed based on participant reports from focus group discussions. Its purpose was to collect data on socio-demographic factors, occupational health problems and physical, verbal and sexual harassments in the work place among garment factory workers. The questionnaire was administered by two medical pre-interns (individuals who have graduated from medical school in Sri Lanka) trained in the use of the survey tool.

3.1.2.5 The World Health Organization Quality of Life Brief Questionnaire

The World Health Organization Quality of Life (WHOQOL) questionnaire is a cross-culturally comparable quality of life assessment instrument that measures the broad domains of physical health, psychological health, social relationships, and environment. The WHOQOL-BREF is a shorter (26-item) version of the original questionnaire, and includes two stand-alone questions that allow the respondent to rate his self-perceived health and quality of life. The WHOQOL-BREF has been validated in numerous cultural settings, including Sri Lanka, as a reliable survey tool (World Health

Organization, 1996; Kumarapeli, Seneviratne, & Wijeyaratne, 2010). This instrument (WHOQOL-BREF) was used in the form of self-administered questionnaire to collect data on factory worker quality of life.

3.2 Data Management and Analysis

3.2.1 Data Coding

The primary outcome interest was the presence of musculoskeletal symptoms – included pain, aching, stiffness, burning, numbness, or tingling – of the neck, shoulders, elbow or forearm, wrist or hand, back, or knees occurring more than 3 times or lasting a week or more during the preceding 12 months. It was unnecessary for symptoms to be directly caused by a workplace injury or activity. The presence of any symptom at any body region was recorded as a dichotomous value (present or absent), however additional data further classifying the location and features of complaints were also collected. This information was used to better characterize the nature of musculoskeletal health problems in this population, but was not further manipulated for use in regression analysis.

Independent variables of interest included *age, BMI, job type, education, time in industry, monthly income, residence* (home vs. boarding), and *lifetime alcohol and lifetime tobacco* use. Age was recorded as 8 categories as described in Table 1. Since the majority of women were younger than 30 years, age categories were set for small, equal (5-year)

increments beginning at 20 years of age. The categorical arrangement of respondent age was selected over a continuous treatment of the variable as it permitted the detection of non-linear relationships with age. Five-year increments (as compared to larger ranges) allowed for better resolution of changes in outcome prevalence, as well as a more balanced distribution of respondents across categories. Despite waning numbers among older groups, discrete categories were assigned up to age 55 years (rather than simply designating a final category ≥ 40 years) so as not to dilute the predictive effect of advanced age.

BMI was calculated from height and weight measures obtained at the time of interview using the following conversion:

$$\text{BMI} = \frac{\text{mass (kg)}}{(\text{height (m)})^2}$$

The Singapore BMI category cutoffs (<18.5, 18.5 - <23, 23 - <27.5, 27.5 and above) were adopted over traditional BMI ranges, as these may be more applicable to Asian populations (Nishida, Barba, Cavalli-Sforz, Cutter, Darnton-Hill, Deurenberg, *et. al.*, 2004).

Job type was classified based upon anticipated physical demands and risks of each position. Seamstresses spend the day seated at a sewing machine, while quality control assistants sort through and inspect finished garments. Ironers, packers, and cutters stand for the duration of their shift, bent forward at the waist over their work.

Recorders, helpers, and supervisors, though often on their feet all day, have the most freedom to move about the factory.

Schooling in Sri Lanka is free, compulsory until grade 9 (age 14), and based on the British educational system. Ordinary level (O-level) achievement is equivalent to graduation from the 11th grade, while Advanced level (A-level) indicated 2 years of additional study and the successful completion of rigorous testing. Given the high rates of formal schooling in Sri Lanka, educational attainment was recorded categorically to differentiate those not finishing basic schooling from those completing O-levels, and individuals achieving A-levels or higher.

Time (months) spent working in the garment industry was recorded as a continuous variable. The number of months worked in the garment industry ranged from 0 to 276 (23 years), with a mean of 63.7 ($\pm$ 49.5). This variable was subsequently converted to a categorical schema during data coding to decrease the influence of outliers, and is more fully described in Table 1.

Table 1: Variable coding

Variable	Description	Coding
Age	Reported age (years)	Categorical (8); <20, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-55
BMI	Calculated based on measurements	Categorical (4); < 18.5, 18.5 - < 23, 23 - <27.5, ≥27.5
Job type	Current employment	Categorical (4); 1: Seamstress; 2: Quality control assistant; 3: Ironer, packer, cutter; 4: Recorder, helper, supervisor
Education	Highest level of schooling completed	Categorical (3); Grade 10 or below, Ordinary level (grade 11), Advanced level or graduate school
Time in industry	Garment factory work, any location	Categorical (5); < 12 mo., 12 – 35 mo., 36-59 mo., 59-119 mo., ≥120 mo.
Monthly income	Current income (LKR)	Categorical (4); Quartiles as follows: 1 st <8301, 2 nd 8301 – 9210; 3 rd 9211 – 10,200; 4 th >10,200
Residence	Home vs. other	Dichotomous; Family home = 1; Other = 0

3.2.2 Descriptive Analysis

Descriptive statistics for the cohort were tabulated for age, BMI, job type, educational attainment, months spent working in the garment industry, average monthly income, residence, and lifetime alcohol and tobacco use. Group mean and standard deviation were also reported for *age*, *BMI*, *time in industry*, and *monthly income*. The variables *lifetime alcohol use* and *lifetime tobacco use* were dropped from subsequent analysis due to lack of variance.

3.2.3 Bivariate and Multivariate Regression Analysis

3.2.3.1 Bivariate Regression Analysis

Key demographic variables (*age, BMI, job type, education, time in industry, monthly income, and residence*) were individually assessed via bivariate logistic regression modeling for their relation to the outcome of interest (musculoskeletal symptoms at any location). Advanced age, low educational attainment, and greater duration of employment have all been previously reported to associate with higher prevalence of musculoskeletal complaints among garment workers (Kaergaard & Andersen, 2000; Bharathi, 2007; Choobineh, Tabatabaee, Mokhtahrzadeh, & Salehi, 2007; Choobineh, Tabatabaee, & Behzadi, 2009; Deros, Daruis, Ismail, Rifqi, & Rahim, 2010; Saha, Dasgupta, Butt, & Chattopadhyay, 2010). The relationship between obesity (BMI ≥ 27.5) and MSD is well documented among adolescents and adults (Taylor, Theim, & Mirch, 2006), however its association with work-related diseases remains poorly defined (Schulte, Wagner, Ostry, Blanciforti, Cutlip, Krajnak, *et. al.*, 2007). Job type was identified as a potential risk factor (work-specific activities predispose individuals to particular injury patterns) and thereby included in this analysis, while monthly income may indicate improved access to resources (*e.g.* health care) among higher earners. Though living conditions (home vs. boarding house) may not directly impact workplace injury risk, high levels of psychological stressors have been shown to correlate with elevated rates of illness (Hoogendoorn, Bongers, & de Vet, 2002).

3.2.3.2 Multivariate Regression Analysis

All variables were included in the full multivariate logistic regression model. Variables were then systematically removed from the full model based upon bivariate regression modeling (p-values) and likelihood-ratio testing of the resultant multivariate models (Table 2). This method of backward elimination was used to exclude variables that did not improve the fit of the final multivariate model. Akaike information criteria was used to assess the goodness of fit of the final adjusted model and the full model. No multivariate analysis was undertaken to assess predictors of location-specific (*e.g.* back) complaints, since there were quite few women reporting these problems.

Table 2: Likelihood-ratio testing for variables included in full and final multivariate regression models

Model	Variables omitted	LR test statistic	DF	p-value
Full	none	--	--	--
A	<i>age</i>	27.80	7	0.0002*
B	<i>BMI</i>	1.18	3	0.7567
C	<i>job type</i>	2.63	3	0.4525
D	<i>education</i>	1.07	2	0.5850
E	<i>time in industry</i>	9.68	4	0.0461*
F	<i>monthly income</i>	13.16	3	0.0043*
G	<i>residence</i>	0.58	1	0.4456

3.2.4 Quality of Life (WHOQOL-BREF) Analysis

Returned completed WHOQOL-BREF surveys were scored and converted to a 100-point scale to enable direct comparison, as described in the literature (World Health Organization, 1996). Questions 1 and 2, which asked respondents to rank their health satisfaction and quality of life, were scored independently on a scale of 1 (very dissatisfied/very poor) to 5 (very satisfied/very good). Responses were then dichotomized (1: satisfied/good or better (scores 4 and 5); vs. 0: neither satisfied nor unsatisfied/good nor bad or worse (scores 1, 2, and 3)) to facilitate the construction of two-by-two tables for analysis purposes. Odds ratios for association with musculoskeletal complaints (at any location) were calculated for each question independently. Distributions were evaluated by 2-tailed chi-squared test, with a 0.05 level of significance.

3.3 Ethical Approval

Ethical clearance was obtained from both from the Ethical Review Committee of Faculty of Medicine, University Ruhuna, Sri Lanka and from the Duke University Medical Center Institutional Review Board. Permission to conduct this research was obtained from the General Manager, FTZ, Koggala. Data collection was carried out after obtaining informed consent from the study subjects.

4. Results

The musculoskeletal survey was completed by 1058 (99.2%) randomly selected women; they represented 13.9% of female workers employed in garment factories in Koggala. The self-completed quality of life questionnaire (WHOQOL-BREF) was returned by 1057 (99.1%) of the cohort.

4.1 Cohort Demographic Profile

All participants were Sinhalese. Worker age ranged from 17 to 54 years (Table 3), with a mean of 28 (SD 7.3, median 26). More than two-thirds were under 30 years of age. Nearly half (44.7%) of the women had a BMI within the normal healthy range for Asian women, while 28.1% were underweight and 3.5% obese. Educational attainment was uniformly high with just 135 (12.8%) participants having failed to advance beyond the 10th grade. More than one quarter (26.7%) had reached A-level or higher, indicating the potential for advanced (graduate) schooling. All respondents denied any tobacco or alcohol use in their lifetime.

Table 3: Characteristics of 1058 female garment workers in Kogalla, Sri Lanka

	<i>N</i>	%	<i>M ± SD</i>
Age (yr)			27.8 ± 7.3
<20	74	7.0	
20-24	323	30.5	
25-29	317	30.0	
30-34	160	15.1	
35-39	88	8.3	
40-44	61	5.8	
45-50	23	2.2	
50-55	12	1.1	
BMI (Singapore/Asian)			20.9 ± 3.6
<18.5	297	28.1	
18.5 - < 23	473	44.7	
23 - < 27.5	251	23.7	
≥ 27.5	37	3.5	
Job type			
Sewing machine	674	63.7	
Quality control	106	10.0	
Ironer, packer, cutter	220	20.8	
Recorder, helper, supervisor	58	5.5	
Education			
Grade 10 or below	135	12.8	
O level	641	60.6	
A level, graduate	282	26.7	
Time in industry (months)			63.8 ± 49.5
<12	57	5.4	
12 - <36	270	25.5	
36 - <60	242	22.9	
≥60	489	46.2	
Monthly income (LKR)			9629 ± 2029
1 st quartile	279	26.4	7791 ± 550
2 nd quartile	252	23.8	8834 ± 335
3 rd quartile	268	25.3	9747 ± 358
4 th quartile	259	24.5	12,260 ± 2352
Residence			
Family home	904	85.4	
Other	154	14.6	
Total	1058	100.0	

The majority of the factory women (85.4%) lived in their family home, and nearly all (98.9%) arrived at work via the company bus. Average commute time was 34.7 (SD 23.1) minutes per day, with one individual reporting a group high of 2.5hr of daily travel. Most women (63.7%) were employed as sewing machine operators. Two hundred twenty workers (20.8%) were responsible for cutting, ironing, and packing the garments, 106 (10.0%) served as quality control assistants, and 58 women (5.5%) functioned as supervisors, helpers, and recorders. Average time spent working in the garment industry was 63.8 months (SD 49.5, range 1-276), and monthly salaries ranged from 6000 to 20,000 LKR (mean 9629, SD 2029). The top quartile earned on average 4500 LKR more per month than the bottom quartile.

4.2 Musculoskeletal Complaints and Associated Factors

4.2.1 Prevalence of Musculoskeletal Symptoms, Severity, and Impact on Work

Among the participants, 164 (15.5%) female workers reported musculoskeletal symptoms occurring more than 3 times or lasting a week or greater in at least one body region during the previous 12-month period. Nineteen workers (11.6%) reported symptoms at multiple locations, two noting musculoskeletal pain or dysfunction at 5 different sites. The back was the most frequently affected body region, followed by the knees, shoulders, hand and wrist, neck, and forearm and elbow (Table 4).

Average severity of symptoms, regardless of their location, was moderate (mean scores across the 6 body regions ranged 2.5 – 3.0; 1= minimal; 5=severe). The intrusiveness of these musculoskeletal complaints is reflected in the high percentage of individuals reporting difficulty maintaining the quality of their work (55.8 – 83.3%, varying with location of pain) as a result of their symptoms (Table 4). Nearly all women (> 90%) felt that their problems also affected leisure activities and work performed in the home. Despite these symptoms resulting in many workers seeking treatment from a health provider (doctor, physiotherapist, etc.), few women reported missing a day of work as a direct consequence of their discomfort (0.0 – 20.0%).

Table 4: Disruption of work and leisure activities among women reporting musculoskeletal complaints (n=164), Sri Lankan female garment workers.

	N	% with pain severity moderate or greater (n)	% reporting difficulty maintaining work quality (n)	% missing ≥ 1 day of work (n)	% with ≥ 1 visit to health provider (n)	% with symptom interfering with leisure (n)
Location:						
Hand/wrist	12	91.7 (11)	83.3 (10)	16.7 (2)	91.7 (11)	100.0 (12)
Forearm/elbow	5	100.0 (5)	80.0 (4)	20.0 (1)	60.0 (3)	80.0 (4)
Shoulder	15	80.0 (12)	60.0 (9)	0.0 (0)	60.0 (9)	93.3 (14)
Knee	52	82.7 (43)	55.8 (29)	7.7 (4)	69.2 (36)	90.4 (47)
Neck	11	72.7 (8)	63.6 (7)	0.0 (0)	54.6 (6)	100.0 (11)
Back	94	75.5 (71)	69.2 (65)	4.3 (4)	51.1 (48)	94.7 (89)
>1 location	19	94.7 (18)	78.9 (15)	10.5 (2)	78.9 (15)	100.0 (19)
Total (individuals)	164					

4.2.2 Crude and Adjusted (Multivariate) Analysis

Results of bivariate (crude) analysis for all musculoskeletal complaints are presented in Tables 5. Odds of musculoskeletal complaints increased steadily with increasing age. Women with higher monthly income, 60 or more months spent working in the industry, and lower educational attainment (grade 10 or below) were more likely to report musculoskeletal complaints. Individuals designated as obese by Asian BMI standards (≥ 27.5) were slightly more likely to describe symptoms, while those employed at less structured work (recorders, helpers or supervisors) were less likely. Neither of these relationships, however, reached significance. Symptom prevalence was highest among ironers, packers, or cutters.

Prevalence and crude prevalence odds ratios for back and knee symptoms only are reported in Table 6. Older age, higher income, and job tenure greater than 60 months are all positively associated with back pain. Advancing age also correlated with more frequent knee complaints, however the prevalence of knee pain appears to increase more rapidly in the older categories. This may be further reflected in the 4.7-fold higher prevalence odds of knee problems in women with 10 or more years of work in the garment industry. Underweight individuals ($\text{BMI} < 18.5$) were less likely to suffer from knee problems, while those with lower education or those working as ironers, packers, or cutters were 2.4 and 3.5 times more likely to report pain at that location, respectively.

Table 4: Any musculoskeletal complaint crude prevalence odds, by subgroups (n=1058), Sri Lankan female garment workers

		Any musculoskeletal complaint		
		Crude OR	95% CI	p-value
Age (yr)				
	<20	0.37	0.11, 1.25	0.109
	20-24	Ref	--	--
	25-29	1.45	0.90, 2.35	0.125
	30-34	2.03	1.19, 3.47	0.010
	35-39	2.58	1.40, 4.78	0.002
	40-44	3.40	1.75, 6.61	<0.001
	45-50	5.65	2.27, 14.06	<0.001
	50-55	12.30	3.70, 41.0	<0.001
BMI (Singapore/Asian)				
	<18.5	0.73	0.48, 1.13	0.157
	18.5 - < 23	Ref	--	--
	23 - < 27.5	1.23	0.82, 1.84	0.318
	≥ 27.5	2.03	0.94, 4.37	0.071
Job type				
	Sewing machine operator	Ref	--	--
	Quality control assistant	0.83	0.46, 1.52	0.553
	Ironer, packer, cutter, other	1.29	0.87, 1.92	0.203
	Recorder, helper, supervisor	0.41	0.14, 1.15	0.088
Education				
	Grade 10 or below	1.96	1.25, 3.07	0.004
	O level	Ref	--	--
	A level, graduate, and other	1.00	0.67, 1.49	0.996
Time in industry (months)				
	<12	1.84	0.84, 4.04	0.129
	12 - <36	Ref	--	--
	36 - <60	1.27	0.74, 2.19	0.389
	60-119	1.64	1.00, 2.68	0.048
	≥120	3.10	1.83, 5.23	<0.001
Monthly income				
	1 st quartile	Ref	--	--
	2 nd quartile	2.06	1.21, 3.53	0.008
	3 rd quartile	2.38	1.41, 4.00	0.001
	4 th quartile	2.54	1.51, 4.28	0.000
Residence				
	Family home	Ref	--	--
	Other	1.01	0.63, 1.61	0.975

Table 5: Back and knee pain complaints crude prevalence odds and odds ratios by subgroup, Sri Lankan female garment workers

	Back complaints		Knee complaints	
	Crude OR	95% CI	Adjusted OR	95% CI
Age (yr)				
<20	0.50	0.11, 2.21	3.07 e-07	--
20-24	Ref	--	Ref	--
25-29	1.88*	1.02, 3.49	0.83	0.34, 2.03
30-34	2.28*	1.14, 4.56	2.30^	0.99, 5.33
35-39	2.05	0.88, 4.77	2.87*	1.12, 7.38
40-44	3.96**	1.75, 8.95	3.09*	1.10, 8.71
45-50	3.79*	1.16, 12.38	2.70	0.56, 12.99
50-55	6.00*	1.49, 24.21	14.18***	3.70, 54.29
BMI (Singapore/Asian)				
<18.5	1.02	0.61, 1.73	0.41*	0.18, 0.97
18.5 - < 23	Ref	--	Ref	--
23 - < 27.5	1.23	0.73, 2.09	1.17	0.62, 2.23
≥ 27.5	1.74	0.64, 4.72	1.51	0.44, 5.26
Job type				
Sewing machine operator	Ref	--	Ref	--
Quality control assistant	0.62	0.28, 1.39	0.70	0.21, 2.34
Ironer, packer, cutter, other	0.68	0.39, 1.21	2.42**	1.33, 4.41
Recorder, helper, supervisor	0.31	0.07, 1.31	0.86	0.20, 3.69
Education				
Grade 10 or below	1.40	0.78, 2.53	3.54***	1.86, 6.77
O level	Ref	--	Ref	--
A level, graduate, and other	0.88	0.53, 1.48	0.91	0.43, 1.92
Time in industry (months)				
<12	1.63	0.57, 4.70	2.09	0.52, 8.32
12 - <36	Ref	--	Ref	--
36 - <60	1.20	0.58, 2.49	2.32^	0.92, 5.84
60-119	2.11*	1.13, 3.94	1.19	0.45, 3.17
≥120	2.65**	1.33, 5.28	4.70**	1.92, 11.51
Monthly income				
1 st quartile	Ref	--	Ref	--
2 nd quartile	2.15*	1.07, 4.33	1.00	0.40, 2.50
3 rd quartile	2.48**	1.26, 4.89	1.94	0.88, 4.29
4 th quartile	2.48**	1.26, 4.90	1.65	0.73, 3.75
Residence				
Family home	Ref	--	Ref	--
Other	1.22	0.70, 2.17	0.62	0.24, 1.57

In the multiple regression analysis age and time in the industry were significantly associated with musculoskeletal complaints for any location (Table 7). Symptoms increased with age, the oldest age category (≥ 35 years) having 3.5 (1.89-6.57) greater odds of musculoskeletal problems as those 20-24 year old. Compared to 20-24 year-olds (referent), those younger than 20 year were slightly less likely to report pain or dysfunction, though this relationship was not significant. Individuals with less than one year of work experience in the garment industry had a 3.2-fold greater odds of physical symptoms than those with tenure of 1-3 years. This relationship is reversed from the results of the univariate (crude) analysis (Table 5), which found musculoskeletal complaints to be associated with longer employment terms. Odds of symptom reporting also increased with higher income, though the differences between the second, third and fourth quartiles are considerably smaller than the change from the referent (first quartile).

Table 6: Adjusted prevalence odds, full and final multivariate regression models for any musculoskeletal complaint, Sri Lankan female garment workers

	Full model estimates			Final model estimates		
	Crude OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Age (yr)						
<20	0.31	0.09, 1.08	0.066	0.32	0.09, 1.12	0.074
20-24	Ref	--	--	Ref	--	--
25-29	1.61	0.95, 2.72	0.078	1.61	0.95, 2.71	0.076
30-34	2.25	1.19, 4.25	0.012	2.37	1.28, 4.39	0.006
35-39	2.22	1.50, 6.92	0.003	3.43	1.64, 7.15	0.001
40-44	4.05	1.75, 9.41	0.001	4.48	2.02, 9.95	<0.001
45-50	6.66	2.21, 20.14	0.001	7.54	2.66, 21.4	<0.001
50-55	16.05	3.72, 69.22	<0.001	18.84	4.88, 72.7	<0.001
BMI (Singapore/Asian)						
<18.5	0.85	0.54, 1.34	0.489			
18.5 - < 23	Ref	--	--			
23 - < 27.5	0.93	0.60, 1.45	0.757			
≥ 27.5	1.34	0.59, 3.05	0.487			
Job type						
Sewing machine operator	Ref	--	--			
Quality control assistant	0.75	0.40, 1.43	0.387			
Ironer, packer, cutter, other	1.90	0.58, 1.39	0.628			
Recorder, helper, supervisor	0.48	0.16, 1.42	0.187			
Education						
Grade 10 or below	1.29	0.77, 2.15	0.341			
O level	Ref	--	--			
A level, graduate, and other	0.96	0.61, 1.49	0.844			
Time in industry (months)						
<12	3.44	1.47, 8.09	0.005	3.23	1.39, 7.51	0.007
12 - <36	Ref	--	--	Ref	--	--
36 - <60	0.91	0.51, 1.62	0.755	0.88	0.50, 1.56	0.659
60-119	0.75	0.42, 1.34	0.332	0.74	0.42, 1.31	0.305
≥120	0.79	0.38, 1.61	0.514	0.74	0.36, 1.49	0.395
Monthly income						
1 st quartile	Ref	--	--	Ref	--	--
2 nd quartile	2.23	1.26, 3.96	0.006*	2.35	1.34, 4.12	0.003*
3 rd quartile	2.35	1.32, 4.20	0.004*	2.48	1.41, 4.35	0.002*
4 th quartile	2.68	1.48, 4.86	0.001*	2.86	1.60, 5.09	<0.001*
Residence						
Family home	Ref	--	--			
Other	1.22	0.74, 2.01	0.440			
Model diagnostics (AIC)	886.21782			874.04657		

4.3 Worker Quality of Life and Health Satisfaction

Quality of life (WHOQOL-BREF) total and domain scores are reported in Table 8.

Respondents scored highest in physical health, which includes ability to perform activities of daily living, energy levels, pain and discomfort, and work capacity. Scores were lowest for the psychological domain (self-esteem, spirituality, memory and concentration). There was no significant difference in total or average domain scores between those reporting any musculoskeletal symptoms and those free of complaints.

Most women reported their quality of life to be good or very good (54.4%), though “neither good nor poor” was the largest single response category (44.9%). Nearly half of all respondents (47.5%) were satisfied with their present health. Forty-nine individuals reported dissatisfaction with their health, and just 7 considered their quality of life to be poor or very poor. Moderate or worse self-perceived quality of life and health satisfaction were independently associated with higher rates of musculoskeletal complaints (Table 8).

Table 7: Quality of life (WHOQOL-BREF) and self-reported assessments by presence or absence of musculoskeletal complaints, Sri Lankan female garment workers

WHO Quality of Life (mean scores)	MSK (SD)	No MSK (SD)	All (SD)	RR
Psychological	41.1 (11.0)	42.7 (12.2)	42.5 (12.0)	0.99
Social	57.5 (25.0)	57.5 (24.5)	57.5 (25.0)	1.00
Environmental	63.9 (13.4)	64.9 (14.2)	64.6 (14.1)	0.99
Physical	69.2 (15.1)	70.4 (14.9)	70.2 (14.9)	1.00
Total WHOQOL-BREF Score	57.7 (12.3)	58.9 (12.4)	58.7 (12.4)	0.99
Moderate or worse self-reported...	MSK (n=164)	No MSK (n=893)	Total (n=1057)	Odds Ratio
Quality of life	90	391	481	1.56*
Health satisfaction	79	303	382	1.81*

* Chi-squared test; 2-tailed p-value < 0.05

5. Discussion

5.1 Musculoskeletal Problems Among Garment Workers

5.1.1 Principal Findings

This study describes the self-reported musculoskeletal symptoms among 1058 women drawn from a random sample of actively employed female garment factory workers in the Koggala FTZ. The overall prevalence of complaints was surprisingly low (15.5%), with the back (8.9%) and knee (4.9%) the most commonly noted sites of pain or dysfunction. While most women (88.4%) reported symptoms from a single location, several suffered from multiple musculoskeletal problems. Symptoms, regardless of their location, were frequently associated with moderate to severe pain and were reported to interfere significantly with both the women's work and leisure activities. Despite its disruptiveness, however, very few women reported missing work as a direct result of their symptoms (*e.g.* to seek treatment, to take sick leave).

Ironers, packers and cutters had the greatest prevalence of musculoskeletal pain, followed by sewers, quality control assistants, and supervisors and recorders. BMI of 27 and greater was associated with a small increased odds of musculoskeletal problems, however this trend disappeared after adjusting for other factors. Self-reported symptoms increased with age. As in this study, lower educational attainment has also been reported by others to be associated with higher rates of pain and dysfunction

among garment workers (Kaergaard & Andersen, 2000; Saha, Dasgupta, Butt, & Chattopadhyay, 2010). However, the relationship did not persist after adjusting for other factors in our analysis and was excluded from the final model.

Individuals working in the industry for less than one year were significantly more likely to report muscle or joint symptoms. This is consistent with other studies reporting that new workers may actually be at higher risk of injury than their more experienced colleagues (Sokas, Spiegelman, & Wegman, 1989; Häkkänen, Viikari-Juntura, & Martikainen, 2001), and may reflect an early conditioning period during which women adjust to the physical demands of factory work, a healthy worker effect, or other selection bias in this cross-sectional analysis. The prevalence of site-specific complaints other than back and knee were too low to assess their relationships to the risk factors.

The majority of women employed in Sri Lankan garment factories are satisfied with their current quality of life and health status. Quality of life measures were highest for the physical domain and lowest for the psychological domain, a finding that is appears to be unique for this population and is described in greater detail below. Lower self-rated quality of life and health satisfaction were both associated with higher rates of musculoskeletal complaints, though more objective measures (WHOQOL-BREF) revealed no such relationship.

5.1.2 Factory Workers in the Developing World

Prior evaluations of garment workers in India, Bangladesh, Fiji, Lithuania, and the United States reveal musculoskeletal complaints to be among the most common ailments among these predominantly female populations (Gamperiene & Stigum, 1999; Herbert, Dropkin, Warren, Sivin, Doucette, Kellogg, *et. al.*, 2001; Chan, Janowitz, Lashuay, Stern, Fong, & Harrison, 2002; Sarder, Imrhan, & Mandahawi, 2006; Chand, 2006; Joseph & Kiran, 2008; Saha, Dasgupta, Butt, & Chattopadhyay; 2010). Estimates of musculoskeletal disease prevalence vary widely (12-80%), though the distribution of pain locations remains relatively consistent. Back, neck, and upper extremity problems among sewing machine operators are well documented in the literature (Punnett, Robins, Wegma, & Keyserling, 1985; Blader, Barck-Horst, Danielsson, Ferhm, Kalmpamaa, Leijon, *et. al.*, 1991; Andersen & Gaardboe, 1993), being reported by up to half of all respondents.

The prevalence of musculoskeletal problems amongst these Sri Lankan garment workers was quite low, with just a handful of sewing machine operators reporting upper extremity or neck pain. This is surprising as the garment industry typically carries one of the highest rates of neck and shoulder pain relative to other manufacturing fields (Schierhout, Meyers, & Bridger, 1995). Problems relating to the back were more common among machine operators, as well as for workers employed at other tasks. The distribution is similar to findings from a cohort of garment workers in

Dhaka, Bangladesh (Sarder, Imrhan, & Mandahawi, 2006). In both Bangladesh and Sri Lanka, workers reported lower rates of musculoskeletal problems than their Western counterparts (Chan, Janowitz, Lashuay, Stern, Fong, & Harrison, 2002; Herbert, Dropkin, Warren, Sivin, Doucette, Kellogg, *et. al.*, 2001). Significant differences with regards to respondent demographics, in particular the more advanced age of Lithuanian and US workers, may account for the dissimilar results noted above, but the possibility of cultural differences accounting for some variability should not be dismissed.

Other sites of musculoskeletal pain frequently reported by manual laborers include the knees and thighs, though such symptoms amongst garment workers have been largely overshadowed in the literature by the prevalence of upper extremity and neck problems. Surveillance at Iranian sugar and rubber factories found that nearly half of the all-male respondents suffered from ongoing knee pain; a significantly greater proportion than the general Iranian male population (Choobineh, Tabatabaei, Mokhtarzadeh, & Salehi, 2007; Choobineh, Tabatabaei, & Behzadi, 2009). Age and job tenure were positively correlated with musculoskeletal symptoms of any kind, while back and knee problems accounted for the highest frequency of sick leave. Lower extremity pain is also associated with prolonged periods of standing (Tissot, Messing, & Stock, 2009) and is thus more likely to be reported by garment workers not employed as sewing machine operators. Ironers, packers, and cutters in this cohort noted knee pain at more than twice the rate of other workers. It is unclear why this subgroup of workers may

have a greater risk of knee symptoms relative to other standing jobs (quality control assistant, helper, etc.). Further research, including a thorough evaluation of workplace ergonomics, could help to resolve this question.

5.2 Quality of Life of Females in Sri Lanka

Little is known with regards to the mental health and emotional wellbeing of the general population of Sri Lanka. Much of the literature has focused on the quality of life of women suffering from various forms of cancer, though such efforts have utilized an assessment tool specific to cancer research (*i.e.* Quality of Life module of the European Organization for Research and Treatment of Cancer, EORTC QLQ-CX24). Just two studies have evaluated Sri Lankan populations by means of the WHOQOL or WHOQOL-BREF.

The first, an assessment of women with polycystic ovarian syndrome (PCOS), opted for the 26-question WHOQOL-BREF and found significantly lower psychological (64.9 vs. 68.8), social (60.5 vs. 66.8), and physical (64.8 vs. 69.4) domain scores relative to controls (Kumarapeli, Seneviratne, & Wijeyaratne, 2010). No such differences between groups were found in this present study of female garment workers, however, factory workers on average scored lower than women in the PCOS study in the domains of psychological (42.5) and social health (57.5). Physical and environmental health scores were comparable to healthy controls from the PCOS study.

A second evaluation of the quality of life of filarial lymphedema patients in Sri Lanka used the full 100-question WHOQOL survey, and reported domain results on a scale of 4-20 (Wijesinghe & Wickremasinghe, 2010). Healthy individuals had better quality of life scores for all health domains, as well as better overall general quality of life, as compared to patients with filarial lymphedema. Among healthy controls only, individuals scored lowest in social health, a finding not dissimilar to the results reported by Kumarapeli and colleagues (2010) and in this current study.

The impact of musculoskeletal disorders on quality of life is well described in the literature (van Duijn, Lötters, & Burdorf, 2004; Kovacs, Abaira, Zamora, Teresa Gil del Real, Llobera, Fernández, *et. al.*, 2004). In this evaluation objective measures of quality of life were unable to elucidate the influence of musculoskeletal pain or dysfunction on mental wellbeing. Though prior studies of specific groups within Sri Lanka have demonstrated a deleterious effects of illness on psychological and social health, the case-control design of such inquiries permitted investigators to capture individuals with more advanced and disruptive disease than is likely to be found by the cross-sectional design employed here. This population of actively employed female workers must be in good enough health to consistently fulfill the duties of a demanding factory job. As discussed earlier with regards to musculoskeletal complaints in older individuals, a healthy worker bias may be at play.

Finally, though objective measures of wellness differed little between groups, self-perceived quality of life and health satisfaction were lower among women reporting any musculoskeletal disorder. The cross-sectional design of this study, however, renders it impossible to discern the presence of any cause-effect relationship; thus it cannot be determined whether physical symptoms influence perception or if a poorer general outlook predisposes an individual to illness. Additionally, as the self-administered WHOQOL-BREF survey was given to participants that had already completed the primary health survey, individuals admitting to musculoskeletal problems may have been primed to consider themselves in poorer overall health.

5.3 Cultural Context of Study Findings

The economic transformation that occurred in Sri Lanka over the previous three decades has significantly altered traditional gender norms, allowing women to take on new roles as the independent wage-earners and even primary breadwinners for their families (Attanapola, 2004). Changes in the work environment, living conditions (*e.g.* for some women, moving to boarding houses), and community support structures are the result of these women's evolving social status. These factors are likely to influence women's experiences, perceptions, and management of their own health and wellness. Prior studies of the garment industry in Sri Lanka FTZs have largely focused on its social and economic impact on women (Hancock, 2005; Bharathi, 2007; Lynch, 2007;

Hancock, Middleton, & Moore, 2009). Despite numerous qualitative accounts of poor working conditions resulting in various health problems, little was previously known about the prevalence of musculoskeletal conditions among these women as a whole and its impact on their professional and personal lives.

Chronic and recurrent episodes of joint pain are physically and psychologically disruptive as well as financially costly, both for the worker and her employer (Lynch, 2007). Absenteeism, reduced efficiency, and declining work quality, regardless of their cause, may be grounds for termination. In this cohort, female garment factory workers suffering from musculoskeletal problems were unlikely to miss a day of work despite reporting high levels of pain and the disruption of work and leisure activities in association with their symptoms. Though most women reported at least one visit to a health practitioner as a result of their problem, very few ever took time off from work to obtain care or rest from potentially aggravating activities.

This incongruence may to some extent reflect the incomplete empowerment of the modern Sri Lankan working woman. Though a member of the formal labor force, many women still retain their traditional roles as obedient daughter, wife, and mother, feeling substantial social pressures to adopt a subservient attitude towards financial decision-making in the home (Attanapola, 2004; Hancock, 2005; Hancock, Middleton, & Moore, 2009). In such cases, the decision to take leave from work for the purpose of seeking medical care may be left to the male head of household or factory supervisor

(most commonly male). It is unclear whether such sociocultural expectations play a role in the lower psychological and social domain scores noted among women this and other studies (Kumarapeli, Seneviratne, & Wijeyaratne, 2010). How this potential lack of control over one's health care is perceived by this population and to what degree it impacts individual productivity and mental and physical health is an interesting topic for further studies.

5.4 Limitations

This study used a cross-sectional survey and regression modeling to detect correlations between musculoskeletal complaints and demographic characteristics of female factory workers. All data were collected at a single point in time, permitting the determination of disease prevalence as opposed to its incidence. As a result, a direct cause-and-effect relationship cannot be definitely identified through analysis undertaken in this study. Prevalence is a result of disease incidence and duration, both of which require longitudinal studies (*e.g.* repeated cross-sectional surveys) for evaluation. A snapshot of garment worker health, though potentially effective at identifying individual risk factors, offers limited insight into the mechanisms through which these factors have their effect. Thus while the study may accurately reveal that workers with on-the-job experience of less than 1 year have an increased risk of musculoskeletal

injury, the means by which their risk is increased (*e.g.* technical inexperience, lack of conditioning, greater physical activity outside of the factory, etc.) remains unclear.

This assessment of female garment workers relied upon accurate self-reporting of recognized symptoms by individuals present at the factory during the time of interview. Inherent in this setup is the potential for healthy worker bias, such that the prevalence of musculoskeletal problems among this cohort may have been underestimated. Additionally, the survey asked the respondents to recall events that may have occurred over the preceding 12-months. While some complaints may have been forgotten, it is likely that we captured the more significant episodes. A shorter recall period may have produced a more accurate estimate of disease prevalence.

Another limitation important to consider when interpreting the results of this study is the potential influence of unmeasured factors of working conditions. Estimations of the physical demand of work were simplified through the careful construction of job categories. Objective assessments of individual ergonomics, workplace stress, and environmental exposures were not performed. Neither were individuals asked to rate specific physical or psychological aspects of their work (*e.g.* time spent bending, amount of supervisor support, etc.). Even the simple classification of workplace exposures (*e.g.* low, medium, high) and subjectively reported measures of the psychosocial environment can be useful tools for better defining risk factors

(Chaffin & Park 1973; Videman, Nurminen, Tola, Kuorinka, Vanharanta, & Troup, 1984; Waters, Dick, & Krieg, 2011).

The very high response rates (>96 %) for both instruments are very interesting and worthy of further exploration. While such a high level of compliance raises concerns for compulsory participation, sociocultural factors and the presence of a monetary reward complicate this simplistic interpretation. The 200 LKR compensation offered those completing the two surveys approximates a single daily wage for the average female factory worker.

5.5 Opportunities for Future Study

Future research efforts should consider innovative approaches to validation of findings that might explore the feelings of women participants. For example, do female workers feel coerced to participate in research studies, and how does this sense of obligation impact their willingness to report symptoms and events? To what degree do these women feel compelled to respond in a socially acceptable manner (*e.g.* neglecting to report instances of physical or mental abuse)? This potential for reporting bias reveals an opportunity for investigators to employ elements of community-based participatory research in future studies (Wallerstein & Duran, 2006). Under such a model, used previously with good success in the United States among both Black female poultry processors and urban Indian Americans, employees or local community members are

involved in data collection from peers (Lipscomb, Argue, McDonald, Dement, Epling, James, *et. al.*, 2005; Johnson, Bartgis, Worley, Hellman, & Burkhart, (2010).

The health status of female garment workers has yet to be compared to the general Sri Lankan female population. Such a contrast would be useful to better appreciate both the positive and negative health effects of factory employment on its female workers and seems like a logical next step. Longitudinal investigations could also provide meaningful information regarding the long-standing effect of garment factory work on the physical health of female laborers, as well as the impact of musculoskeletal disease on mental wellbeing and overall quality of life. Finally, given the uncharacteristically low prevalence of musculoskeletal disease among this population of garment workers, an evaluation of workplace ergonomics within these factories may reveal simple measures capable of reducing the risk of illness and injury for females engaged in factory work elsewhere in the developing world.

6. Conclusion

The prevalence of musculoskeletal disorders among female garment workers in the FTZ of Kogalla is lower than that reported by comparable populations in both the developed and developing world. Back and knee complaints comprise the majority of problems in this group, a surprising finding given the well-described association of garment work with neck and shoulder pain. Though objective quality of life measures did not differ between groups, self-reported assessments were generally lower among individuals describing pain or dysfunction. The influence of a healthy worker bias should not be underappreciated when interpreting the results of this study.

Though these workers are quite young and sociocultural factors may effect a degree of underreporting, the generally good health of Sri Lankan workers suggests that the developing world industries can achieve safe work environments within their FTZs factories. Further research is necessary to better understand the psychosocial impact of work-related physical and sociocultural factors in this unique population.

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